IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 12 Ser. 7 (December. 2025), PP 47-52
www.iosrjournals.org

A Comparative Evaluation of Height of Maxillary Occlusion Rim Obtained by the Mathematical Formula Derived from the Palatal Dimensions with the Occlusion Rim that is Fabricated Using Conventional Method-An Analytical Observational Study

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Abstract:
Background*: This study* ***proposes a new method for establishing the height of the maxillary occlusion rim in a completely edentulous patient using mathematical correlation between the anteroposterior length of the palate and the depth of the palate in dentulous subjects.***
Materials and Methods: *Lateral cephalogram of 100 dentulous and 100 edentulous subjects was obtained. The anteroposterior length of the palate was measured between the anterior nasal spine (ANS) and posterior nasal spine (PNS). The highest point on the palatal cusp of the second premolar tooth on the right and left side of the arch was joined by stainless steel wires on the cast. The depth of the palate was measured using a divider from this plane in the midline. Using these values, a simple linear regression equation was derived: Y = 0.058 (X) + 18.36, where Y = Depth of palate (dependent variable), X = ANS–PNS Distance (independent variable).*
In an edentulous patient, the value of the length of the palate was inserted into the above equation, and the depth of the palate was determined. Two sets of record bases and occlusion rims were made. One occlusion rim was adjusted in the patient's mouth according to esthetics, phonetics, and the camper's line. The second occlusion rim was fabricated by using the above mathematical equation. The height of the two maxillary occlusion rims was compared.
Results*: The mean height of the occlusion rim derived from the mathematical formula was 21.309 mm with a standard deviation of 0.20 mm. The mean height of the maxillary occlusion rim by the conventional method was 18.68 mm, with a standard deviation of 1.61 mm. The unpaired t-test with p value (p<0.001) showed a highly significant statistical difference.*
Conclusion: *This study proves that the linear regression formula to prepare the maxillary occlusion rim height can be used for fabricating a maxillary occlusion rim for edentulous subjects with adequate maxillo-mandibular space and a short palate.*

Key Word*: – Occlusal plane, Campers plane, Simple linear regression formula, ANS-PNS distance.*

Date of Submission: 11-12-2025 Date of Acceptance: 21-12-2025

I. Introduction

The occlusal plane is defined as the average plane established by the incisal and occlusal surfaces of the teeth. (GPT-9) [1]. When all the teeth are lost, the occlusal plane is lost. To establish the lost occlusal plane in the oral cavity, simulating the original occlusal plane is a very tough task. The use of pre-extraction records to achieve the plane of occlusion in edentulous patients has been advocated for many years [2,3]. In the absence of previous records, investigators [4,5,6] have suggested various concepts or methods for the orientation of the occlusal plane based on morphologic studies on natural and artificial dentitions and also on clinical judgement. However, no one has shown an easy method for locating the occlusal plane correctly for every patient. This difficulty may be attributed to the lack of physiological knowledge of occlusal plane orientation. Even though the ala tragal line (called Camper's line when it is a plane from the inferior border of the ala of the nose to the superior border of the tragus of the ear) is the most commonly used landmark and the only extra-oral landmark used to establish the posterior occlusal plane in edentulous subjects, its use still remains controversial.

To the best of our knowledge, none have suggested the importance of depth of palate as a guideline for determining the vertical height of occlusion rim and the appropriate occlusal plane for prosthetic rehabilitation. Literature is limited in locating the correct height of occlusion rim in reference to the depth of the palate. Hence, this study was planned to determine the mathematical correlation between the anteroposterior length of the palate and the depth of the palate in dentulous subjects and the application of this mathematical correlation in edentulous patients to fabricate the maxillary occlusion rim.

II. Materials and Methods

This prospective comparative study was carried out on patients of the Department of Prosthodontics at MGV KBH Dental College and Hospital, Nashik, India. A total of 200 subjects (both dentulous and edentulous patients) were in this study.

Study Design: Analytical observational study

Study Location: This was an observational study done in the Department of Prosthodontics at MGV KBH Dental College and Hospital, Nashik, India

Study Duration: August 2020 to November 2021.

Sample size: 300 patients.

Subjects & selection method:

GROUP A: Dentulous subjects (n= 100); GROUP B: Edentulous subjects (n =100)

Group I-B (test group) - Occlusion rim made by the derived formula. (n= 100)

Group II-B (control group) - Occlusion rim made by the conventional method. (n= 100)

The study was conducted in two parts:

1. Mathematical formula derived from the dentulous patients using the ANS-PNS distance from the lateral cephalogram and depth of palate.

2. a) Occlusion rim fabricated for an edentulous patient using the mathematical formula derived from dentulous patients.

b) Occlusion rim fabricated for an edentulous patient by the conventional method.

Inclusion criteria:

1. Criteria employed for the selection of dentulous subjects: Systemically healthy dentulous subjects with a complete set of permanent natural dentition.

2. Criteria employed for the selection of edentulous subjects: Normal healthy, completely edentulous patients within the age group of 40 to 60 years were selected for the study.

Exclusion criteria:

1. Subjects having a history of trauma or fracture to the maxillary or mandibular ridge.

2. Subjects having palatal tori.

Procedure methodology

1. A mathematical formula was derived from the dentulous patients using the ANS-PNS distance and depth of palate. The lateral cephalogram radiographs were recorded for all 100 dentulous subjects. Tracing of dentulous lateral cephalometric radiographs was made using three-orientation marks and two anatomical landmarks, namely the Anterior nasal spine (ANS) and Posterior nasal spine (PNS). The distance between the ANS and PNS was measured (anteroposterior length of palate).

Impressions of the maxillary arch were made using irreversible hydrocolloid impression material. Impressions were poured in dental stone (Type III), and casts were obtained. The highest points on the palatal cusps of the second premolar tooth on the right and left sides of the arch were marked on the cast. These points were joined by using 23-gauge stainless steel wire, which was fixed with wax on the cusps, and a plane was established. In the middle of the cast, the depth of the palate was measured from this plane made by stainless steel wires (Figure 1). The values of anteroposterior length of palate and depth of palate in dentulous subjects were studied, and a correlation was obtained between them. This correlation was used to derive the equation given below.

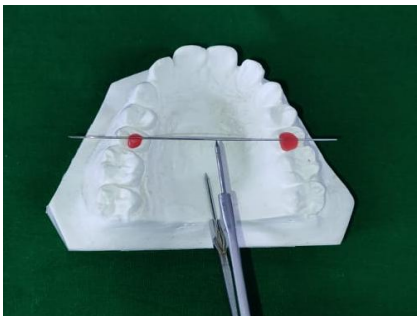

Figure 1: Plane made by stainless steel wire

SIMPLE LINEAR REGRESSION FORMULA:
$y = ax + b$
Based on this, a regression formula was derived:
$y = 0.058 (x) + 18.36$
Where, y = Depth of palate (dependent variable)
x = ANS – PNS Distance (independent variable)
This equation provides the relation between the anteroposterior length of the palate and the depth of the palate.
2. a) Occlusion rim fabricated for an edentulous patient using the mathematical formula derived from dentulous patients
Lateral cephalometric radiographs were made for all 100 edentulous subjects. Tracing the edentulous lateral cephalometric radiographs was done using the three orientation marks and the main landmarks - the Anterior nasal spine (ANS) and Posterior nasal spine (PNS). The distance between the ANS and PNS was measured (anteroposterior length of palate). (Figure. 2)

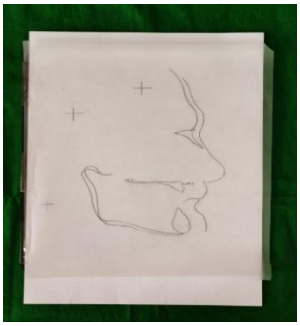

Figure.2- Distance between the ANS and PNS was measured on the lateral cephalogram

The value of the anteroposterior length of the palate was put in the simple linear regression formula, and the calculations were carried out to obtain the depth of the palate. The depth of the palate represents the distance from the midline of the palate on the cast to the height of the occlusion rim.
2.b) Fabrication of occlusion rims according to the conventional method:
Occlusion rim was fabricated according to ideal measurements and adjusted in the patient's mouth according to esthetics, phonetics, and camper's line of the patient (Figure 3).

Figure. 3-camper's line of patients

The anterior occlusal plane was established by maintaining it parallel to the interpupillary line and 1- 2 mm visible when the patient spoke. Next, the posterior occlusal plane was established parallel to the ala tragus line,

which in this study was considered at the middle border of the tragus of the ear to the lower border of the ala of the nose (Figure .4). The height of the two maxillary occlusion rims was measured from the deepest part of the vestibule. Comparison between the heights of both occlusion rims was done.

Figure. 4 -height of occlusion rims measured from the deepest part of the vestibule.

Method of Data Analysis:

Statistical Product and Service Solution (SPSS) version 21 for Windows (Armonk,NY:IBM corp) software was used to analyze the data. Statistical analysis was done by using tools of descriptive statistics, such as Mean and SD for representing quantitative data. Student t-test / Unpaired t-test used to compare between means of two groups independent of each other, i.e. height of the rim calculated from two different methods, i.e., from a mathematical formula and a conventional method.

III. Result

Table 1: Descriptive statistics of measurements in Group A (Dentulous Patients)

	Mean	SD	SE	Minimum	Maximum
ANS-PNS Distance	**53.67**	**5.27**	**0.52**	**43.0**	**69.0**
Depth of Palate	**21.46**	**1.87**	**0.18**	**17.0**	**26.0**

Table 2: Linear regression analysis between ANS-PNS distance and Depth of Palate in Group A (Dentulous patients)

	Unstandardized Coefficients		Standardized Coefficients	t value	Significance
Model	**B**	**Std. Error**	**Beta**	**9.601**	**P<0.001****
(Constant)	**18.360**	**1.912**	**0.162**		
ANS-PNS distance	**0.058**	**0.035**			

On analyzing relationship between ANS-PNS distance and depth of palate in Group A (Dentulous Patients), there was found to be a linear relationship between ANS-PNS (independent variable) and Depth of Palate (Independent variable) which can be explained below in the regression formula: **y = 0.058 (x) + 18.36** Where x – Independent variable (Predictor) i.e. ANS-PNS Distance, y – Dependent variable (Depth of Palate)

Table 3: Comparative statistics of height of rim for Group B (Edentulous) calculated from derived mathematical **formula (Group IB) and height of Rim by Conventional Method (Group IIB)**

	Mean	**SD**	Mean Difference ± SE	Unpaired 't' test	p value, Significance
Group IB (Mathematical Formula)	**21.309**	**0.20**	**2.629 ± 0.163**	**t =16.104**	**P<0.001****
Group II B (Conventional Method)	**18.68**	**1.61**			

****p<0.001 – highly statistically significant difference**

IV. Discussion

The occlusal plane plays an important role in the fabrication of a complete denture. The most useful tool in regard to locating and determining the exact and effective orientation of the occlusal plane is Camper's plane, which is also known as a line joining the ala of the nose to the tragus of the ear. A study conducted by Siefert[7] considered the Frankfort horizontal plane in locating the occlusal plane. He utilized anatomic landmarks in reference to the occlusal plane. A study conducted by Karkazis and Polyzois [8] in 1991 used radiographs in

assessing occlusal plane, whereas Shigali et al [9] used soft tissue landmarks. But still, there is no standardized method to locate the occlusal plane in all types of subjects.

In the present study, palatal dimensions (palatal length and palatal depth) were studied in 100 dentulous subjects to derive a correlation between the length and depth of the palate. The strong correlation found between the length and depth of the palate was used to derive a linear regression formula, which gave the depth of the palate if the length of the palate was known. Later, Lateral cephalograms of 100 edentulous subjects were taken to measure the length of the palate (ANS-PNS distance) and to determine the height of the maxillary occlusion rim in edentulous subjects by inserting the values in the linear regression formula. Correlation between ANS-PNS distance and depth of palate in Group B (Edentulous subjects) derived using Pearson 'r' correlation coefficient, which was found to be r = 1.000, which indicates a Strong positive correlation. The mean height of the occlusion rim derived from the mathematical formula was 21.309 mm with a standard deviation of 0.20 mm. The mean height of the maxillary occlusion rim by the conventional method was 18.68 mm. with a standard deviation of 1.61 mm. The Mean Difference ± SE for the height of rim calculated from the derived mathematical formula (Group IB) and height of Rim by the Conventional Method (Group IIB) was 2.629 ± 0.163. The unpaired t-test was applied as the means of both the independent groups were compared. The p-value is $p<0.001$, which shows highly statistically significant difference.

Monteith [10] 1985 postulated a relationship between the Porion-Nasion-Anterior Nasal Spine (Po N Spna) and the angle between the Frankfort plane and the occlusal plane, and proposed a mathematical formula to calculate the inclination of the cephalometrically determined occlusal plane on the articulator. In 2009 Ahmad ZM[11] studied palatal dimensions and its correlation with the circumference of upper anterior teeth. He found that the mean measurement was 13.2911 mm for Inter first premolar depth and 18.0919 mm for Inter second premolar depth. In the present study, the depth of the palate was measured from the plane established in dentulous patients from the palatal cusp of the maxillary 2nd premolar on both sides. The mean depth of the palate was found to be 21.46 mm, and the SD was 1.87 mm. In 2013, Hindocha et al [12] conducted a cephalometric study to determine the plane of occlusion in completely edentulous patients, which seems to support the findings of Monteith and a mathematical formula correlation (between the PoNANS angle and angulation of the plane of occlusion). A similar negative correlation was found to exist between the PoNANS angle and the angulation of the plane of occlusion. For males: $Y = - 0.5115 (X) + 48.1$ and for females: $Y = - 0.7434 (X) + 65.27$.

In 2017, Tantray MA et al [13] conducted a study comparing the occlusal plane in dentulous and edentulous subjects in relation to maxillo-mandibular space with the help of cephalometrics. Maxillo-mandibular space length was calculated from the ANS and PNS distance on a cephalogram. In the present study, we also used the lateral cephalograms. The ANS and PNS are considered stable landmarks of the palate. Depending upon the length of the palate and the maxilla-mandibular space height, the patients were classified as 1) long and high, 2) long and low, 3) short and high, and 4) short and low. In the present study, we used the same classification to categorize the subjects in which a mathematical formula can be used to determine the height of the maxillary rim, as 1) long and high, and 2) short and high

Limitations of the study:

The height of the maxillary occlusion rim fabricated using the linear regression formula was useful in subjects with adequate maxilla-mandibular space and short palatal length.

As the depth of palate and length of palate is different in the male and female population same formula cannot be generalized for the population. Thus, further study needs to be done for the male and female populations separately. The depth of the sulcus may vary due to intraoral muscle attachment and the location of the buccal frenum, which may give different results when recording the height of the occlusion rim.

V. Conclusion

The mean height of the maxillary occlusion rim fabricated using the mathematical correlation, which was derived from the ANS-PNS distance and depth of palate of dentulous patients, was more than the rim that was adjusted in the oral cavity, fabricated using the conventional method. The height of the maxillary occlusion rim fabricated by the mathematical formula falls in the range of 20-21 mm, whereas the height of the maxillary occlusion rim adjusted in the oral cavity by the conventional method is in the range of 18-22 mm. There was a highly significant statistical difference between the rims fabricated from these two methods. This study proves that the linear regression formula to prepare the maxillary occlusion rim height can be used for fabricating a maxillary occlusion rim for edentulous subjects with adequate maxillo-mandibular space and a short palate.

References

[1]. The Glossary of Prosthodontic Terms: Ninth Edition. J Prosthet Dent. 2017 May;117(5S):e1-e105.
[2]. Merkeley HJ. A complete standardized pre extraction record. J Prosthet Dent. 1953; 3:657-659.
[3]. Wright WH. Use of intra oral jaw relation wax records in complete denture prosthesis. JADA.1939; 26:542-557.

[4]. Augsburger RH. Occlusal plane relation to facial type. J Prosthet Dent. 1953; 3:755.
[5]. Hartono R. The occlusal plane in relation to facial types. J Prosthet Dent. 1967; 17:549- 559.
[6]. Ismail YH, Bowman JF. Position of the occlusal plane in natural and artificial teeth. J Prosthet Dent. 1968; 20:407-411
[7]. Seifert, D., Jerolimov, V., Carek, V., & Ibrahimagić, L. Relations of Reference Planes for Orientation of the Prosthetic Plane. Acta stomatologica Croatica, 2000; 34, 413-416.
[8]. Karkazis HC, Polyzois GL. Cephalometrically predicted occlusal plane: Implications in removable prosthodontics. J Prosthet Dent 1991;65:258-64.
[9]. Shigli K, Chetal BR, Jabade J. Validity of soft tissue landmarks in determining the occlusal plane. J Indian Prosthodont Soc 2005;5:139-45.
[10]. Monteith BS. A cephalometric method to determine the angulation of the occlusal plane in edentulous patients. J Prosthet Dent 1985;54:81-7.
[11]. Ahmad ZM. Palatal Dimensions and Its Correlation with the Circumference of Upper Anterior Teeth. Al–Rafidain Dent J. 2009; 9(2): 259– 267.
[12]. Hindocha AD, Vartak VN, Bhandari AJ, Dudani MT. A cephalometric study to determine the plane of occlusion in completely edentulous patients. Indian J Dent Res. 2013 Nov-Dec;24(6):669-73.
[13]. Tantray, M.A., Shah, S.A., & Bali, S.K. Evaluation of the occlusal plane in dentulous patients in relation to maxillomandibular space in Kashmiri population. International Journal of Applied Dental Sciences, 2017.3, 89-95.